इंटरनेट मानक

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IS 15769 (2008): Flux cored (tubular) electrodes for gas shielded and self-shielded metal welding of carbon or carbon-manganese steel [MTD 11: Welding General]

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कार्बन-मैगनीज़ इस्पात के गैस परिरक्षित और स्व-परिरक्षित धातु आर्क वैलडन के लिए फ्लक्स क्रोडी (नलिकाकार) इलैक्ट्रोड

Indian Standard

FLUX CORED (TUBULAR) ELECTRODES FOR GAS SHIELDED AND SELF-SHIELDED METAL WELDING OF CARBON OR CARBON-MANGANESE STEEL

ICS 25.160.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

July 2008

Price Group 9

Welding General Sectional Committee, MTD 11

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Welding General Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard describes the requirement for continuous flux cored (tubular) electrodes for metal arc welding with or without shielding gas.

The use of flux cored electrodes has expanded greatly. These growth in the use and application of flux cored electrodes has been stimulated by developments in electrode manufacturing technology that have permitted the production of smaller diameter electrodes and by improvements in formulation of the core ingredients.

This standard covers the following:

a) Classification system for the flux cored tubular electrodes for metal arc welding of carbon or carbon manganese steels.

b) Classification has been given on the basis of chemical composition and the mechanical properties of the weld.

c) Classification also covers surface conditions of flux cored wire.

d) Sample preparation for all weld tests for tensile, impact and chemical composition.

In the formulation of this standard, assistance has been derived from AWS A 5.20-95 'Specification for carbon steel electrodes for flux cored arc welding'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, and expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

FLUX CORED (TUBULAR) ELECTRODES FOR GAS SHIELDED AND SELF-SHIELDED METAL WELDING OF CARBON OR CARBON-MANGANESE STEEL

1 SCOPE

This standard specifies the requirements for continuous flux cored (tubular) electrodes for metal arc welding with and without shielding gas and depositing carbon or carbon manganese steel weld metal having a tensile strength not exceeding 610 MPa. The standard does not cover products intended for submerged arc welding, electrogas arc welding and electroslag welding.

It is recognized that the operating characteristics of flux cored (tubular) electrodes can be modified by the use of pulsed current but for the purposes of this standard, pulsed current is not used for determining the electrode classification.

2 REFERENCES

The standards listed below contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

IS No.	*Title*
1608 : 2005	Metallic materials — Tensile testing at ambient temperature (*third revision*)
1757 : 1988	Method for Charpy impact test (V-notch) for metallic material (*second revision*)
2002 : 1992	Steel plates for pressure vessels for intermediate and high temperature service including boilers (*second revision*)
2062 : 1999	Steel for general structural purposes — Specification (*fifth revision*)
8500 : 1991	Structural steel — Microalloyed (medium and high strength qualities) (*first revision*)
11802 : 1986	Method of determination of diffusible hydrogen content of deposited weld metal from covered electrodes in welding mild and low alloy steels
13851 : 1993	Storage and redrying of covered electodes before use — Recommendations

3 CLASSIFICATION

Classification of flux cored (tubular) electrodes shall be indicated by the following coding system of letters and numerals to indicate the specified properties or characteristics of the electrode.

3.1 Main Coding

It consists of the following characteristics and shall be followed in the order stated:

a) Prefix characteristics 'ET' shall indicate flux cored (tubular) electrodes for metal arc welding.

b) Second characteristic indicates ultimate tensile strength in combination with the yield stress and elongation percentage of the weld metal deposited (*see* **3.3**).

c) Third characteristic indicates the impact values of the weld metal deposited (*see* **3.4**).

d) Fourth characteristic indicates welding position (s) in which the flux cored (tubular) electrode may be used (*see* **3.5**).

e) Fifth characteristic indicates type of core ingredients (*see* **3.6**).

f) Sixth characteristic indicates type of shielding gas (*see* **3.7**).

g) Seventh characteristic indicates whether the flux cored electrode can be used for single pass or for multi-pass welding application (*see* **3.8**).

3.2 Optional Coding

Characteristics H5, H10 and H15 indicate the maximum diffusible hydrogen content in the weld metal (*see* **3.9**).

Example illustrating how electrode copings are established from the above information and the test results obtained are given in Annex A.

3.3 Strength Characteristics

The combination of ultimate tensile strength, yield strength and elongation of the weld metal deposited shall be indicated by the digit 4 and 5 (*see* Table 1).

3.4 Impact Properties

The impact properties of all weld metal deposited for the two tensile ranges (Table 1) shall be as given in Table 2.

3.5 Welding Position

The welding position or positions in which the flux cored (tubular) electrode can be used as recommended by the manufacturer shall be indicated by the appropriate characteristic (designating digits) as given in Table 3.

3.6 The fifth characteristic indicates symbol indicating type of core ingredients as specified in Table 4.

3.7 The sixth characteristic gives symbol indicating type of shielding gas as specified in Table 5.

3.8 The seventh characteristic indicates symbol for single pass or for multipass welding application, as specified in Table 6.

3.9 Optional Coding

Following optional characteristic (symbol) for diffusible hydrogen level as specified in Table 7 can be used for classification, if required.

4 MANUFACTURE

The flux cored (tubular) electrodes may be made by any method that will yield a product conforming to the requirements of this standard. The electrodes shall have a smooth finish, free from surface imperfections, corrosion products, grease or other foreign matters which would adversely affect the quality of weld or the operation of the welding equipment.

NOTE — A suitable protective coating may be applied to flux cored wire (tubular).

4.1 Standard Sizes and Tolerances

The external diameter of a flux cored (tubular) electrode shall be selected from the values given in Table 8 with tolerances appropriate to the specified diameters. The flux cored (tubular) electrodes shall be available in continuous length wound into coils with or without support into drums or into rims and spools.

4.2 Temper, Cast and Helix of Flux Cored (Tubular) Electrode

The temper, cast and helix of electrodes shall be such as to assist smooth feeding of the electrode.

4.3 Uniformity of Flux Cored (Tubular) Core

All flux cored (tubular) electrodes shall have the core ingredients distributed throughout their length with uniformity such that the performance of the electrodes and the properties of the weld metal deposited thereby are not adversely affected.

4.4 Coils with and without Formers, Spools and Pay-off Packs

4.4.1 *General*

Coils spools and pay-off packs shall be of such material and design as to provide adequate protection against damage or distortion of the flux cored (tubular) electrode in normal handling or use. Formers and packing shall also be sufficiently clean and dry to maintain the cleanliness of the electrode.

NOTE — The dimensions of coils without formers shall be agreed between the supplier and the purchaser.

4.4.2 *Coils with Formers*

The dimensions and maximum weight of coils with formers shall be as given in Table 9 and shown in Fig. 1.

4.4.3 *Spools*

The dimensions and maximum weight of spools shall be as given in Table 10 and shown in Fig. 2.

4.4.4 *Pay-off Packs*

Pay-off packs shall have an overall diameter of 600 mm and shall be not more than 1 000 mm in height. They shall contain a maximum of 450 kg of flux cored (tubular) electrode.

4.4.5 *Winding Requirements*

4.4.5.1 Each coil, spool, drum or pay-off pack shall contain one continuous length of electrode. Butt welds, when present in the electrode, shall not interrupt the feeding of the electrode.

4.4.5.2 The flux cored (tubular) electrode shall be wound so as to avoid kinks, ripples or sharp bends which would interfere with the feeding of the electrode and so that it is free to unwind without restriction. The outside end of the electrode shall be accessible and secured.

4.4.6 Information on safety is covered in Annex B.

5 TEST REQUIREMENTS

The tests required for classification determination are specified in Table 11. Test pieces shall be welded without the use of pulsed current. Although it is not expected that every batch of electrodes will be subjected to the initial tests, the manufacturer shall ensure that every batch is capable of passing the initial tests.

Table 1 Designation of Strength Characteristics

(*Clauses* 3.3 *and* 3.4)

Sl No.	Designating Digit	Ultimate Tensile Strength N/mm^2	Yield Strength, *Min* N/mm^2	Elongation Percent, *Min* on $5.65\sqrt{S_o}$
(1)	(2)	(3)	(4)	(5)
i)	4	410-510	330	22
ii)	5	510-610	360	20

Table 2 Impact Strength

(*Clause* 3.4)

Sl No.	Designating Digit	Ultimate Tensile Strength N/mm^2	Temperature for Impact °C	Impact Strength J *Min*
(1)	(2)	(3)	(4)	(5)
i)	0	410-510	No impact requirement	
ii)	1	410-510	27 ± 2	47
iii)	2	410-510	0	47
iv)	3	410-510	– 20	27
v)	4	410-510	– 30	27
vi)	0	510-610	No impact requirement	
vii)	1	510-610	27 ± 2	47
viii)	2	510-610	0	47
ix)	3	510-610	– 20	27
x)	4	510-610	– 30	27
xi)	5	510-610	– 40	27

Table 3 Designation for Welding Position

(*Clause* 3.5)

Sl No.	Designation/Digit	Welding Position
(1)	(2)	(3)
i)	0	Flat and horizontal/vertical
ii)	1	All position
iii)	2	All position except vertical-down
iv)	9	Any position or combination of positions not classified above

Table 4 Symbol for Type of Core Ingredients

(*Clause* 3.6)

Sl No. (1)	Symbol (2)	Core Ingredients (3)
i)	R	Rutile
ii)	B	Basic
iii)	M	Metal cored wires
iv)	G	Other types

Table 5 Symbol for Type of Shielding Gas

(*Clause* 3.7)

Sl No. (1)	Symbol (2)	Core Ingredients (3)
i)	C	Carbon dioxide gas
ii)	M	Mixed gas (75-85% Ar + balance CO_2)
iii)	N	No gas (self-shielded)
iv)	G	Others

Table 6 Symbol for Single Pass or Multi-Pass Welding Application

(*Clause* 3.8)

Sl No. (1)	Symbol (2)	No. of Passes for Which the Flux Cored (Tubular) Electrode can be Used (3)
i)	1	Single-pass
ii)	9	Multi-pass

Table 7 Symbol for Diffusible Hydrogen Level in the Deposited Weld Metal

(*Clause* 3.9)

Sl No. (1)	Symbol (2)	Maximum Diffusible Hydrogen Control ml/100 g of Deposited Weld Metal (3)
i)	H 5	5(1)
ii)	H 10	10(1)
iii)	H 15	15

(1) Flux cored (tubular) electrodes classified for the optional hydrogen levels may be considered classified to all hydrogen levels higher than that to which they are classified.

Table 8 Diameters and Tolerances

(*Clause* 4.1)

Diameter mm (1)	Tolerance mm (2)
0.9	± 0.05
1.0	
1.2	
1.4	
1.6	
2.0	± 0.08
2.4	
2.8	
3.2	

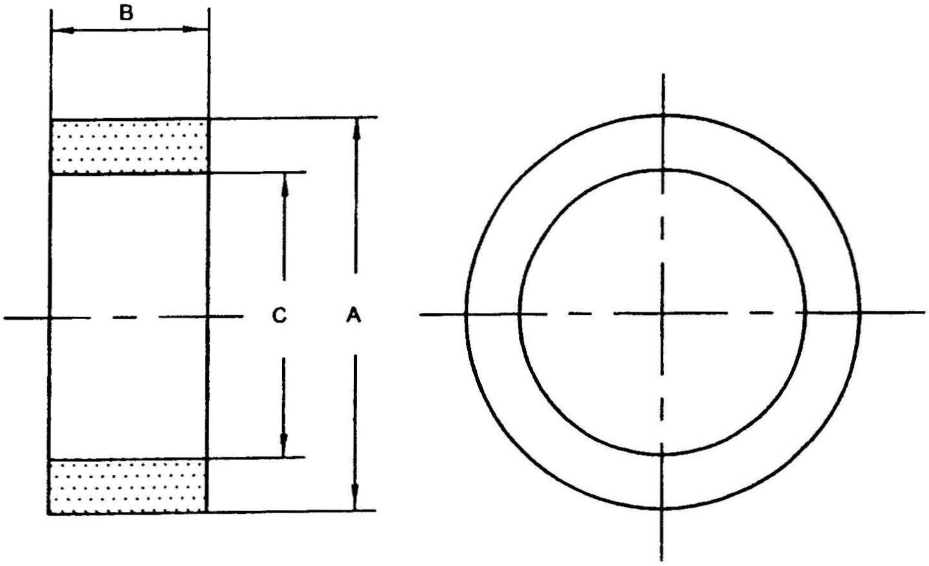


FIG. 1 DIMENSIONS OF COILS WITH FORMERS

Table 9 Dimensions and Maximum Weight of Coils with Formers

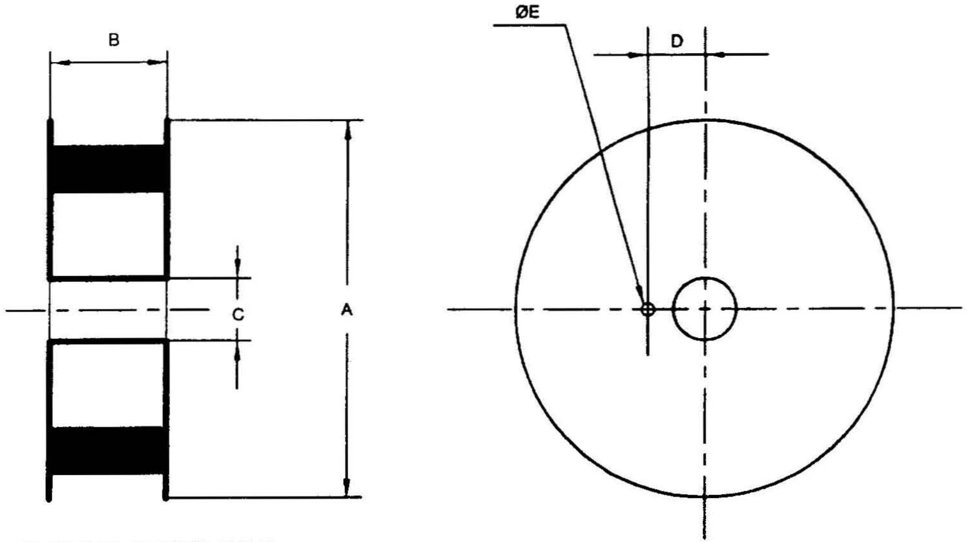
(*Clause* 4.4.2)

Sl No.	Overall Diameter, *A* mm	Width, *B* mm	Inner Diameter, *C* mm	Inner Diameter, *C*, *Max* kg
(1)	(2)	(3)	(4)	(5)
i)	350	65 ± 10	300^{+15}_{-0}	15
ii)	350	90^{+0}_{-15}	300^{+15}_{-0}	20
iii)	350	120^{+0}_{-20}	300^{+15}_{-0}	25
iv)	435	90^{+0}_{-15}	300^{+15}_{-0}	25
v)	435	120^{+0}_{-20}	300^{+15}_{-0}	25

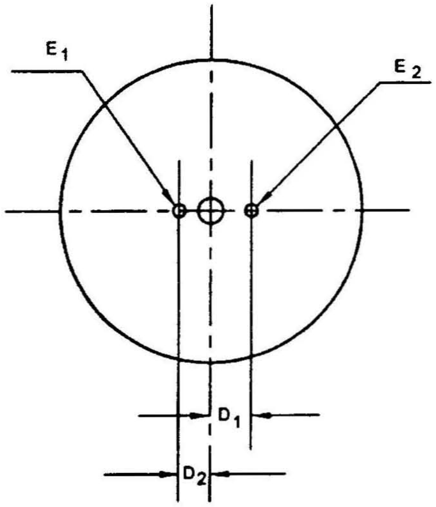
Table 10 Dimensions and Maximum Weight of Spools

(*Clause* 4.4.3)

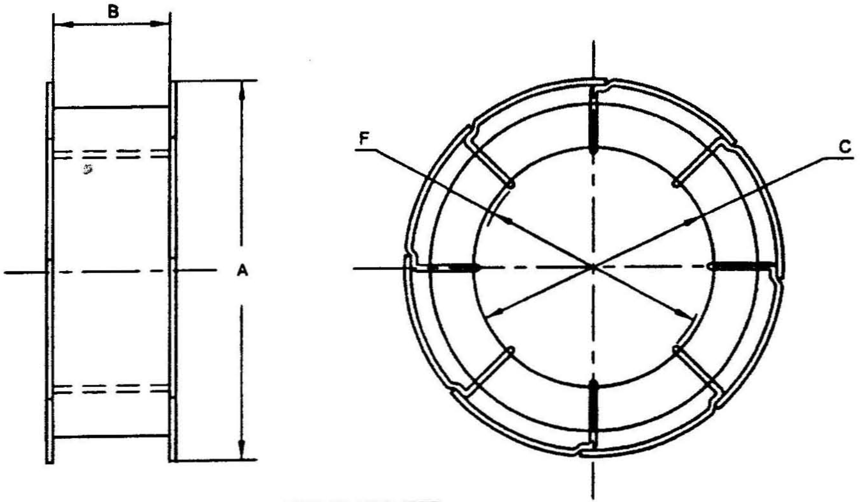
Sl No.	Overall Diameter *A* mm	Overall Width *B* mm	Inner Diameter *C* mm	Distance Between Axes *D* mm	Driving Hole Diameter *E* mm	Weight, *Max* kg
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	100 ± 2	45^{+0}_{-2}	16^{+1}_{-0}	–	–	0.8
ii)	200 ± 3	55^{+0}_{-3}	$50.5^{+2.5}_{-0}$	44.5 ± 0.5	10^{+1}_{-0}	5
iii)	300 ± 5	103 ± 5	$50.5^{+2.5}_{-0}$	44.5 ± 0.5	10^{+1}_{-0}	15
iv)	350 ± 5	103 ± 5	$50.5^{+2.5}_{-0}$	44.5 ± 0.5	10^{+1}_{-0}	15
v)	760^{+0}_{-10}	290^{+10}_{-1}	40.5^{+1}_{-0}	$D_1 = 25 + 1$ $D_2 = 35 + 1$	$E_1 = 65 \pm 1$ $E_2 = 110 \pm 1$	300



2A SINGLE DRIVING HOLE



2B TWO DRIVING HOLES



2C WIRE SPOOL FOR USE WITH DRIVING ADAPTER

FIG. 2 SPOOL DIMENSIONS

Table 11 Required Tests

(*Clauses* 5 *and* 5.1.2.1)

Sl No.	Classification	Chemical Analysis	Radiographic Soundness Text and All Weld Metal Tension Test	Charpy V-Notch Impact Test	Fillet Weld Notch	Transverse Tension Test and Longitudinal Guided Bend Test
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	ET XXXXX-1	Not required	Not required	Not required	Required	Required
ii)	ET XXXXX-9	Required	Required	Required	Required	Not required

5.1 Preparations of Test Assembly

5.1.1 *All-Weld Metal Tests*

5.1.1.1 Two all-weld metal test specimens shall be prepared, one using the smallest size of the electrode manufactured and the other using the largest size of the electrode manufactured from each classification of the electrode using the polarity, current conditions, positions, all welding parameter, etc, as recommended by the manufacturers.

5.1.1.2 The base metal for plates and backing strip to be used for preparations of these assemblies shall conform to IS 2062 and IS 2002 or its equivalent.

5.1.1.3 Shielding gas for preparation of test specimens shall be as recommended by the manufacturers. However, if the products are claimed for both the CO_2 gas and mixed gas, test specimens shall be prepared by using both the gases.

5.1.1.4 The dimensions of these test assemblies are shown in Fig. 3 and given in Table 12. The length of the plate shall be enough to accommodate a tensile test specimen and at least five charpy V-notch test specimen, as shown in the Fig. 3.

5.1.1.5 The plate edges shall be beveled by machining or machine gas cutting. In the latter case, any remaining scale shall be removed from beveled edges. The surface of the backing strip shall be free from rust or scale. All weld metal test pieces shall be prepared, as shown in Fig. 3 by depositing weld metal between the beveled edges of the two plates placed on a backing strip.

5.1.1.6 Welding shall be carried out in flat position with the weld axis and plates horizontal. The plates shall be preset, as shown in Fig. 4 in order to counteract shrinkage deformation in excess of 5°. An assembly that is warped more than 5° from the plane shall be discarded. The direction of welding to complete a pass shall not vary. However, the direction of welding of each layer shall alternate from that of the previous layer. The total number of runs, the number of runs per layer and the total number of layers are shown in Table 13. The reinforcement of the total weld shall not be more than 3 mm.

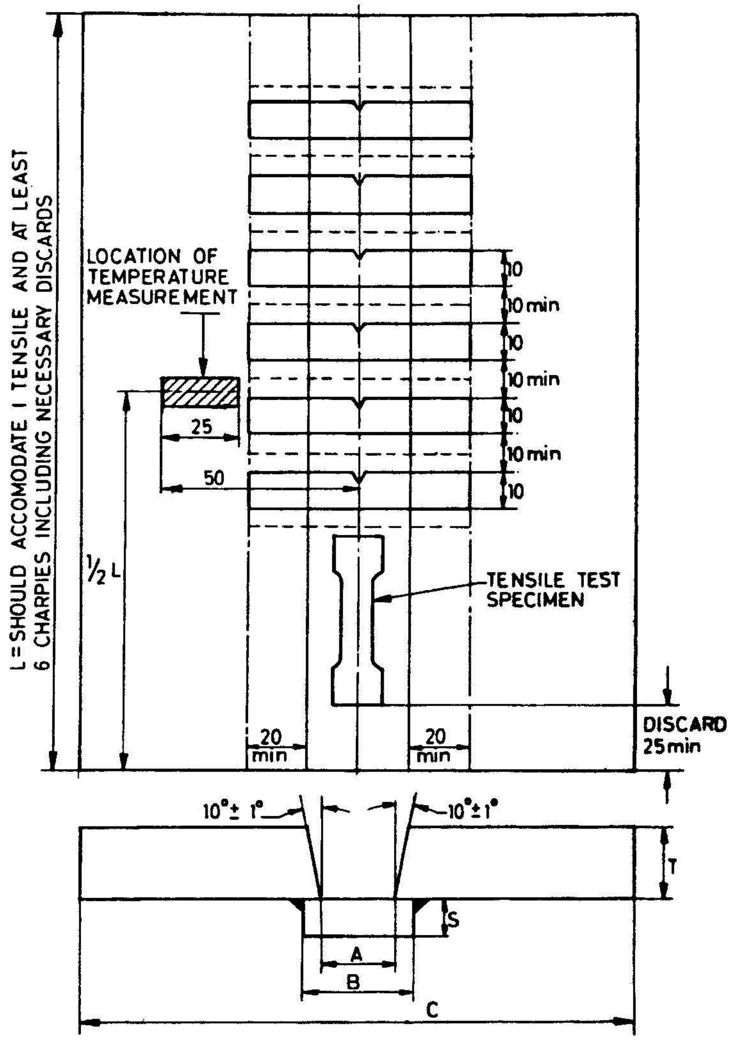
5.1.1.7 The test assembly shall be tack welded at room temperature and welding shall begin at that temperature (20°C minimum). Welding shall continue until the assembly has reached a temperature of 150 ± 15°C, measured by temperature indicating crayons or surface thermometers at a point midway along the test assembly of the surface. This interpass temperature shall be maintained for the remainder of the weld. Should it be necessary to interrupt welding, the assembly shall be allowed to cool in still air at room temperature. The assembly shall be heated to a temperature of 150 ± 15°C before welding is resumed.

5.1.1.8 When the assembly has been welded completely, it shall be allowed to cool in still air to room temperature. The portion including the weld shall then be removed by cutting away the excess plate at the places indicated in Fig. 3. Cutting along the chain lines (shown by ——— – – ——— –) may be done mechanically or by machine gas cutting. If thermal cutting is used, the line of cut shall be at least 10 mm away from the edge of the weld. Along the longitudinal boundaries (shown by broken lines as – – – – – –) of the parts to be machined into impact test pieces, cutting shall be done by mechanical methods only.

5.1.2 *Preparation of Transverse Tensile and Longitudinal Bend Tests Assembly*

5.1.2.1 The plates for transverse tensile and longitudinal bend tests, as required in Table 11 shall conform to IS 2062, IS 2002 or its equivalent for ET4XXXXXX electrodes and shall conform to IS 8500 Fe 540 HT or its equivalent for ET5 XXXXXX electrodes.

5.1.2.2 The test assembly shall be prepared and welded, as shown in Fig. 5 using the welding conditions as recommended by manufacturers. After tack welding the plates at each end, the test assembly shall be welded in the flat position with one bead on


L = SHOULD ACCOMODATE 1 TENSILE AND AT LEAST 6 CHARPIES INCLUDING NECESSARY DISCARDS
LOCATION OF TEMPERATURE MEASUREMENT
25
50
½ L
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10
10 min
10
TENSILE TEST SPECIMEN
DISCARD 25 min
20 min
20 min
10° ± 1°
10° ± 1°
T
S
A
B
C

All dimensions in millimetres.

FIG. 3 DIMENSIONS OF TEST ASSEMBLY AND POSITION OF CUTTING OF TEST PIECES

Table 12 Dimensions of All Weld Metal Test Assemblies

(*Clause* 5.1.1.4)

Plate Width, *C* mm	Plate Thickness, *T* mm	Width of Gap, *A* mm	Backing Strip *Min*, mm	
			Width, *B*	Thickness, *S*
(1)	(2)	(3)	(4)	(5)
120 ± 10	20±1	20±1	*A* + 10	10

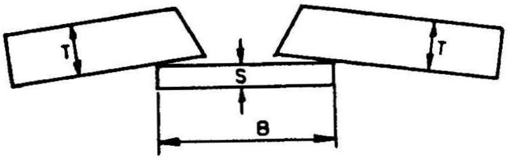


FIG. 4 PRESETTING OF TEST ASSEMBLY

Table 13 Welding Details
(*Clause* 5.1.1.6)

Sl No.	Fluxcored (Tubular) Electrode Diameter, mm	Total Number of Runs	Runs per Layer		Total No. of Layers
			1st layer	Other Layers	
(1)	(2)	(3)	(4)	(5)	(6)
i)	1.20 and under	12 to 19	1 or 2	2 or 3	6 to 9
ii)	1.4 to 2.0	9 to 17	1 or 2	2 or 3	5 to 8
iii)	Over 2.0	7 to 14	1 or 2	2 or 3	4 to7

NOTE — The final layer may have 4 passes.

each side. Welding shall begin with the assembly at room temperature (20°C *Min*). When the weld bead has been completed on one side, the assembly shall be turned over and another bead shall be deposited on the reverse side, as shown in Fig. 5. This sequence shall not be interrupted. The electrode size shall be 2.4 mm dia or the size the manufacturers produce that is closest to 2.4 mm.

5.1.2.3 Shielding gas for preparation of test specimens shall be used as recommended by the manufacturers. However, if the products are claimed for both the CO_2 gas and mixed gas, test specimens shall be prepared by using both the gases. When no shielding gas is recommended, the test specimens shall be welded without shielding gas.

5.1.2.4 The welding conditions shall be those as recommended by the manufacturers for the classification of electrodes being tested. After welding, the assembly shall be cooled in still air to room temperature.

5.1.2.5 One transverse tensile test specimen and one longitudinal bend test specimen shall be prepared, as shown in Figs. 6 and 7.

5.1.3 *Preparation of Fillet Weld Assembly*

5.1.3.1 The base metal for plates to be used for preparing this assembly shall conform to IS 2062, IS 2002 or its equivalent.

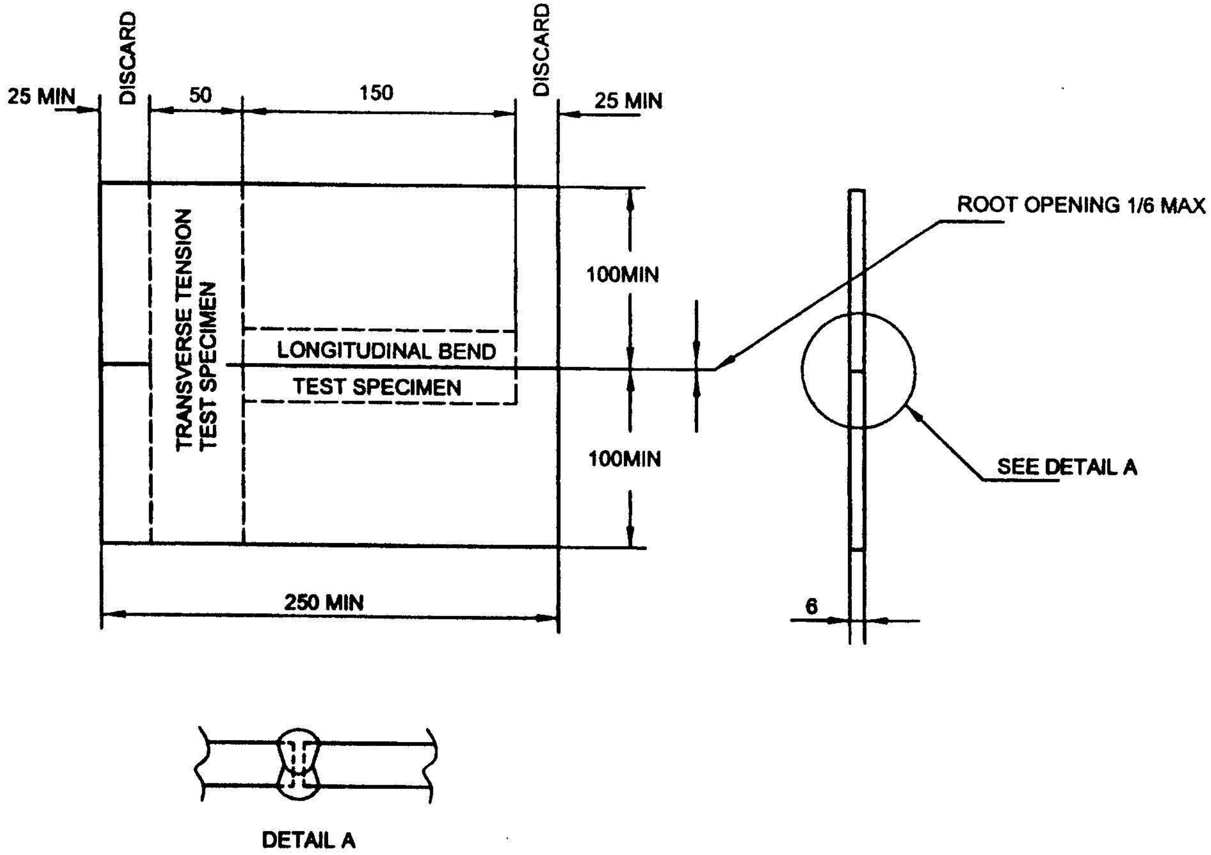
5.1.3.2 A test assembly shall be prepared and welded as required in Table 11 and as specified in Fig. 8 using welding conditions, as recommended by the manufacturer. The plates shall be at room temperature (20°C *Min*) when welding begins.

The flux cored (tubular) electrodes, which are recommended for all position, two fillet test assemblies shall be prepared, one welded in the vertical position and one welded in the overhead position. The progression for vertical welding may be either upward or downward depending upon the classification.

Before assembly, the standing vertical member (web) shall have one edge machined throughout its length and the base member (flange) shall be straight, smooth and clean.

When assembled, the mating (flaying) surfaces shall be in intimate contact along the entire length of the joint. The test assembly shall be secured with tack welds deposited at each end of the weld joint.

After welding has been completed, the assembly shall be cooled in still air to room temperature. After the visual examination, the test pieces shall be cut by



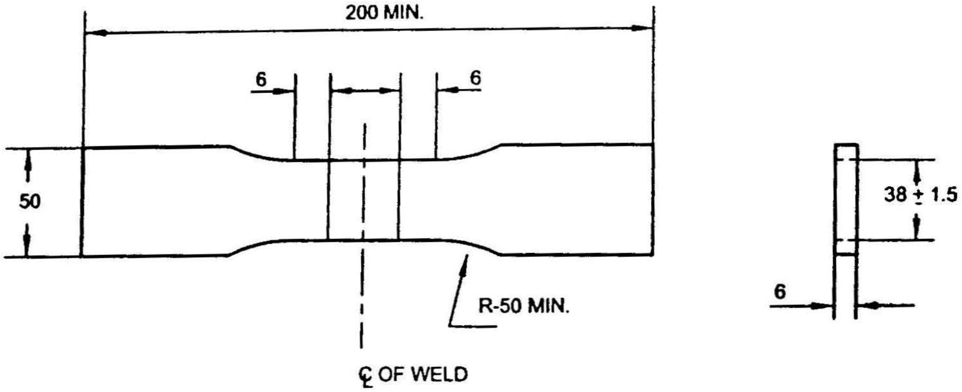
NOTES

1 All dimensions in millimetres.

2 Detail *A* shows the completed joint and approximate weld configuration.

3 Plate thickness may be reduced to 5 mm for electrode of 1.6 mm diameter or smaller.

FIG. 5 TEST ASSEMBLY FOR TRANSVERSE TENSION AND LONGITUDINAL GUIDED BEND TESTS FOR WELDS MADE WITH SINGLE-PASS ELECTRODES

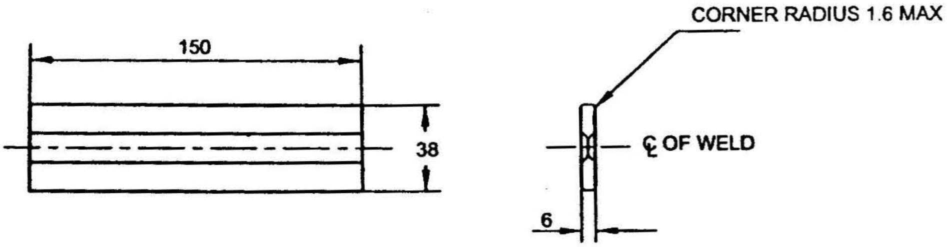


NOTES

1 All dimensions in millimetres.

2 Weld reinforcement shall be ground or machined flush with the surfaces of the specimen. Grinding or machining marks shall be parallel to the length of the longest dimension of the specimen.

FIG. 6 TRANSVERSE TENSION TEST SPECIMEN



All dimensions in millimetres.

FIG. 7 LONGITUDINAL GUIDED BEND SPECIMEN FOR WELDS MADE WITH SINGLE-PASS ELECTRODES

sawing or machining to form one test specimen for macro examination and another for fracture test.

A single run fillet weld having leg lengths of 6 mm to 8 mm for welds made in the vertical-up and overhead positions and 4.00 mm to 6.00 mm for welds made in vertical down positions shall be deposited on one side of the joint. There shall be no indication of crack and the weld shall be reasonably free of undercut, overlap, trapped slag and surface porosity.

The flux cored (tubular) electrode which is recommended for use in horizontal and down hand fillet, only a single run fillet weld in horizontal position shall be deposited using welding parameters as recommended by the manufacturer.

5.1.3.3 Shielding gas for preparation of test specimens shall be used as recommended by the manufacturers. However, if the products are claimed for both the CO_2 gas and mixed gas, test specimens shall be prepared by using both the gases.

5.2 Radiographic Soundness Test

5.2.1 The all-weld assembly shall be prepared for radiographic examination by completely removing the backing material and reducing the weld reinforcement by any suitable mechanical process. The weld ripples and irregularities shall also be removed and the weld face shall merge smoothly into the plate surface. The finished surface of the weld may be flush with the plate to have a reasonably uniform reinforcement, not exceeding 1.5 mm.

5.2.2 The radiograph shall be obtained in accordance with the relevant Indian Standard.

5.2.3 When evaluating the completed radiograph, 25 mm lengths on both ends of the test weld shall be disregarded.

5.2.4 The soundness of the weld metal meets the requirements of this standard, if the radiograph shows no cracks, no incomplete fusion and no rounded indications in excess of the largest size or numbers permitted by the radiographic standards in Fig. 9.

5.2.4.1 A rounded indication is an indication (on the radiograph) whose length is not more than 3 times its width. Rounded indications may be circular, elliptical, conical or irregular in shape and they may have tails. The size of a rounded indication is the largest dimension of the indication, including any tail that may be present. The indication may be of porosity or slag. Test assemblies with indications larger than the largest indications permitted in the radiographic standards (Fig. 9) do not meet the requirements of this standard.

5.3 All-Weld Metal Tensile Test

5.3.1 One all-weld metal tensile test specimen shall be cut (*see* Fig. 10) from the test weld assembly, as described in **5.1.1.8** and shall be prepared as shown in Fig. 11.

5.3.2 Before testing, the specimen may be aged at 250°C for not less than 6 h and not more than 16 h for the purpose of hydrogen release. The specimen shall be cooled to room temperature and subjected to tensile test until rupture in accordance with IS 1608. The results of all-weld tensile test shall conform to the requirements as specified in Table 1.

5.4 Impact Test

5.4.1 Five V-notch Charpy impact test specimens shall be machined from the test assembly and shall be prepared as shown in Fig. 12 for those classifications for which impact testing is required.

The impact test specimens shall be tested in accordance with the impact testing procedure as specified in IS 1757. The test temperature shall be as specified in Table 2, for the classification under test.

5.4.2 In evaluating the test results, the lowest and the highest values obtained shall be disregarded. Two of the remaining three values shall be equal or exceed the specified 47 Joules or 27 Joules, as the case may be. One of the three may be lower but not lower than 41 Joules or 20 Joules as the case may be, and the average of the three shall be not less than the required 47 Joules or 27 Joules energy level.

5.5 Transverse Tensile Test

Each transverse tensile test specimen shall be tested in tension, as per the relevant Indian Standard. The results of the transverse tensile test shall meet the requirements as specified in Table 1. A test specimen that fractures in the base metal shall be considered to have met these requirements.

5.6 Longitudinal Bend Test

After machining, but before testing, the specimen may be agreed at 250°C for not less than 6 h and not more than 16 h and then allowed to cool to room temperature.

5.7 Diffusible Hydrogen Test

5.7.1 The smallest and largest size of the flux cored (tubular) electrode to be identified by an optional supplemental diffusible hydrogen (*see* **3.9**) designator shall be tested according to one of the methods given in IS 11802. Other method such as gas chromatography method may be used as the rapid method for the measurement of diffusible hydrogen.

5.7.2 Testing shall be done with flux cored (tubular) electrode in the as received condition. Conditioning of the electrode, prior to testing, is not permitted.

5.8 Chemical Analysis

5.8.1 The sample for chemical analysis of the all-weld metal shall be obtained for those flux cored (tubular) electrodes for which chemical analysis is given in Table 11.

The sample for chemical analysis of weld metal may be taken from the reduced section of the fractured all-weld metal tension test specimen or from a corresponding location in the weld metal in the all-weld assembly (*see* Fig. 3) thereby avoiding the need to make a weld pad.

5.8.2 The chemical analysis of the weld metal shall be made by any standard method and shall conform to the requirements given in Table 15.

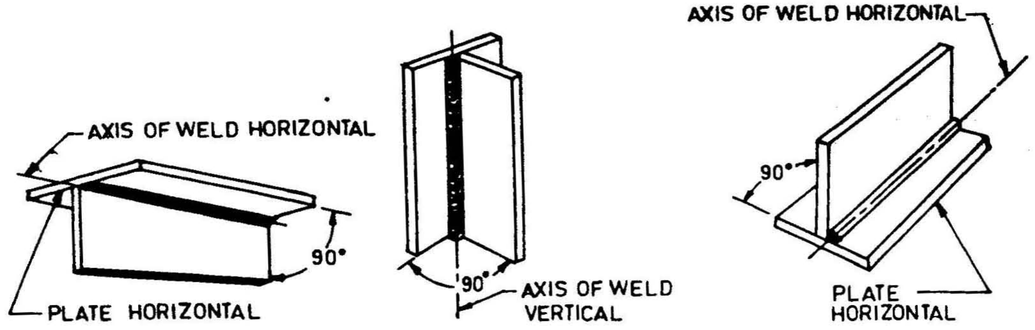
6 RE-TEST

If any test fails to meet the requirements, that test shall be repeated twice. The results of both tests shall meet the requirement. Specimens for the re-test may be taken from the original test assembly or from a new test assembly. For chemical analysis, re-test need to be only for those specific elements that failed to meet the test requirements.

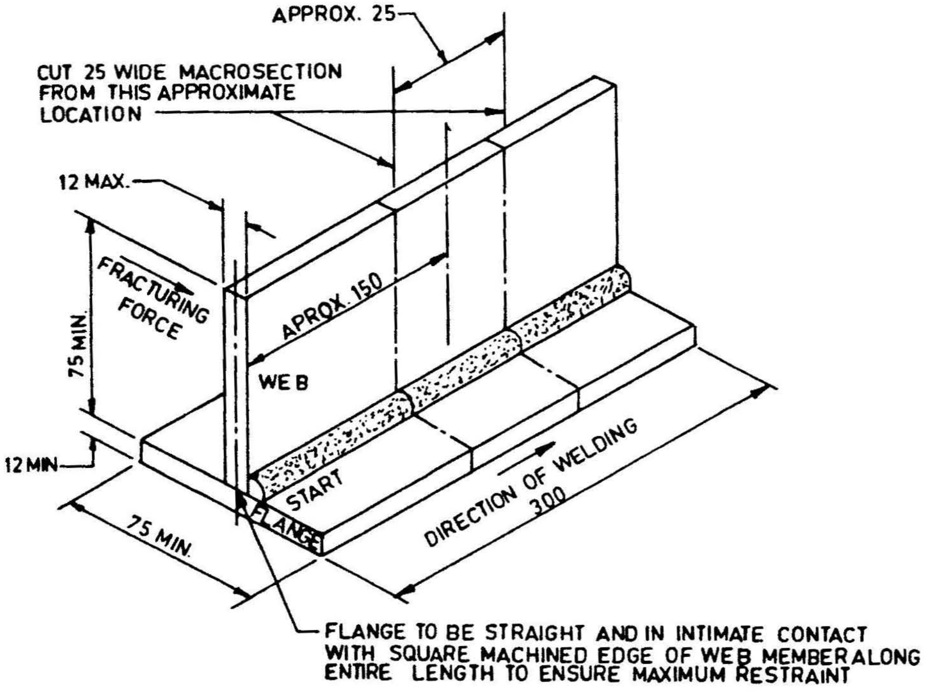
7 PACKING AND STORAGE

7.1 The net mass of an individual bundle or carton of electrodes shall not exceed 7 kg.

7.2 Flux cored wires shall be suitably packed to guard against any damage during transportation. The packing shall be suitable to ensure that under normal store room conditions, the flux cored wires shall, for a period of six months from date of receipt or nine months from date of manufacture, be capable of giving results in accordance with the provisions of this standard and that if the flux covering is a type requiring



(A) OVERHEAD FILLET WELDS (B) VERTICAL FILLET WELDS (C) HORIZONTAL FILLET WELDS

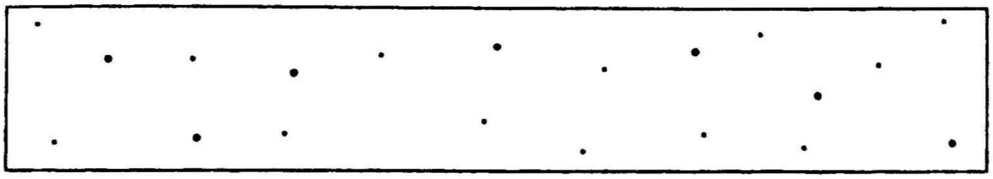

APPROX. 25
CUT 25 WIDE MACROSECTION FROM THIS APPROXIMATE LOCATION
12 MAX.
FRACTURING FORCE
75 MIN.
APROX. 150
WEB
12 MIN
START
FLANGE
75 MIN.
DIRECTION OF WELDING
300
FLANGE TO BE STRAIGHT AND IN INTIMATE CONTACT WITH SQUARE MACHINED EDGE OF WEB MEMBER ALONG ENTIRE LENGTH TO ENSURE MAXIMUM RESTRAINT

NOTES

1 All dimensions in millimetres.

2 If the web and flange thickness are less than or equal to 6 mm, the web and flange widths shall be 51 mm, *Min*.

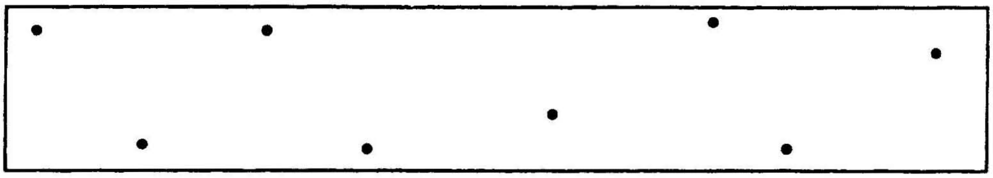
FIG. 8 FILLET WELD TEST ASSEMBLY



(A) ASSORTED ROUNDED INDICATIONS

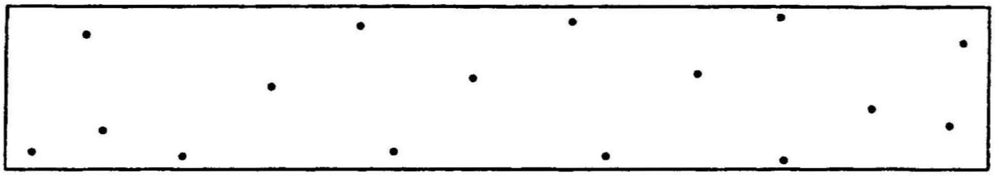
SIZE 0.4 mm TO 1.6 mm, IN DIAMETER OR IN LENGTH
MAXIMUM NUMBER OF INDICATIONS IN ANY 150 mm. OF WELD = 18 WITH THE FOLLOWING RESTRICTIONS.

MAXIMUM NUMBER OF LARGE INDICATION = 3.	1.2 mm TO 1.6 mm IN DIAMETER OR IN LENGTH
MAXIMUM NUMBER OF MEDIUM INDICATION = 5	0.8 mm TO 1.2 mm IN DIAMETER OR IN LENGTH
MAXIMUM NUMBER OF SMALL INDICATIONS = 10	0.4 mm TO 0.8 mm IN DIAMETER OR IN LENGTH



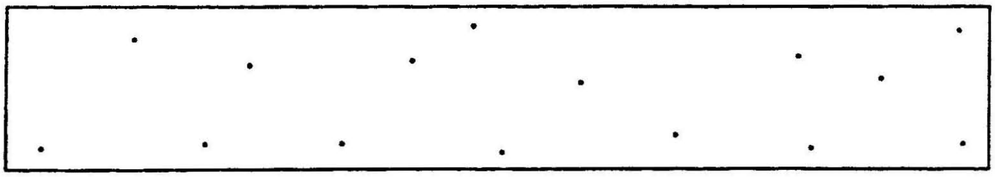
(B) LARGE ROUNDED INDICATIONS

SIZE 1.2mm TO 1.6mm IN DIAMETER OR IN LENGTH
MAXIMUM NUMBER OF INDICATIONS IN ANY 150 mm OF WELD = 8



(C) MEDIUM ROUNDED INDICATIONS

SIZE 0.8mm TO 1.2mm IN DIAMETER OR IN LENGTH
MAXIMUM NUMBER OF INDICATIONS IN ANY 150 mm OF WELD = 15



(D) SMALL ROUNDED INDICATIONS

SIZE 0.4 mm TO 0.8mm IN DIAMETER OR IN LENGTH
MAXIMUM NUMBER OF INDICATIONS IN ANY 150mm OF WELD = 30

NOTES

1. In using these standards, the chart which is most representative of the size of the rounded indications present in the test specimen radiograph shall be used for determining conformance to these radiographic standards.

2. Since these are test welds specifically made in the laboratory for classification purposes, the radiographic requirements for these test welds are more rigid than those which may be required for general fabrication.

3. Indications where the largest dimension does not exceed 0.4 mm diameter or length shall be disregarded.

FIG. 9 RADIOGRAPHIC STANDARDS FOR TEST ASSEMBLY IN FIGURE 3

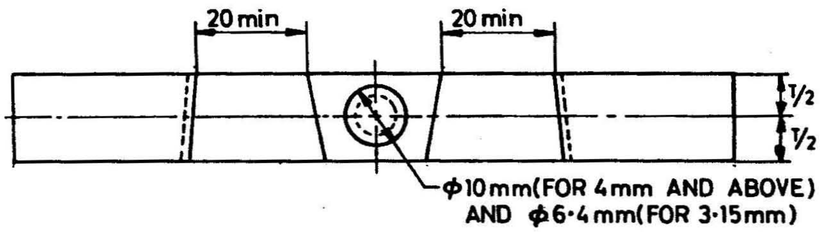


FIG. 10 CUTTING OF TENSILE TEST PIECE

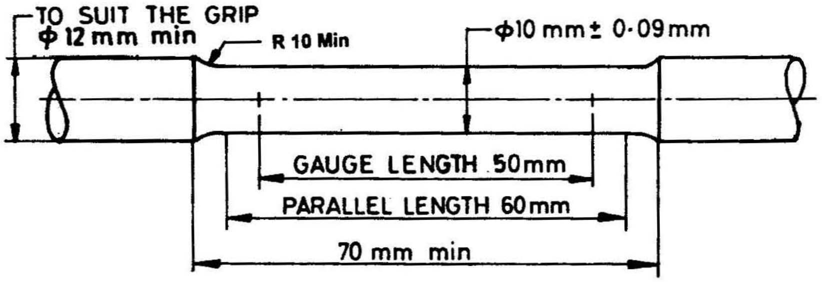
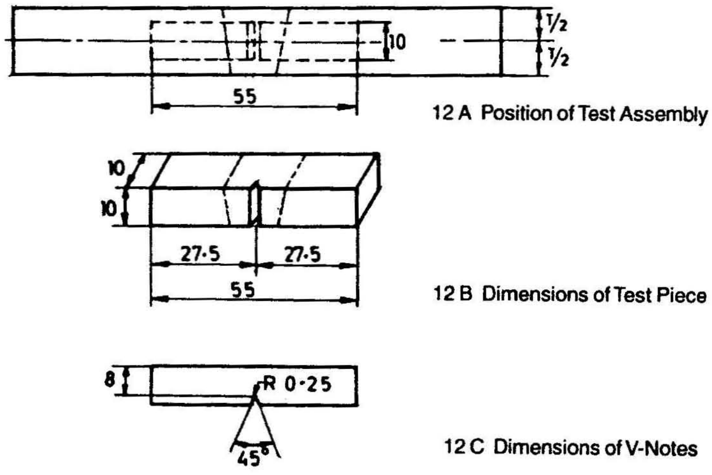


FIG. 11 TENSILE TEST PIECE FOR SIZES 4 mm AND ABOVE



12 A Position of Test Assembly

12 B Dimensions of Test Piece

12 C Dimensions of V-Notes

All dimensions in millimetres.

FIG. 12 IMPACT TEST PIECES/ASSEMBLY

special protection during storage, the details of such special protections shall be furnished by the manufacturer and reference to this should be included in the marking of bundle or carton of flux cored wires . The flux cored wires shall be stored in a dry room condition (*see also* IS 13851).

7.3 The batch of electrodes represented by the electrodes tested shall not be certified as complying with this standard unless the test results obtained satisfy the requirements specified in and the manufacturer has performed the tests at intervals in accordance with the requirements of this standard.

8 MARKING

8.1 As agreed to between the manufacturer and the purchaser, brand name/classification shall be printed on all the electrodes.

8.1.1 Each bundle or carton of electrodes shall be clearly marked with the following information:

a) Classification (*see* **3**);
b) Indicating the source of manufacture;
c) Trade name and brief description of the electrodes;
d) Size and quantity of electrodes;
e) Batch number;
f) Recommended current range, polarity and open circuit voltage;
g) Date of manufacture;
h) Recommendation for special storage conditions and re-drying temperature; and
j) A cautionary note on safety during welding.

8.1.2 *BIS Certification Marking*

The material may also be marked with the Standard Mark.

8.1.3 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Table 15 Chemical Composition Requirements

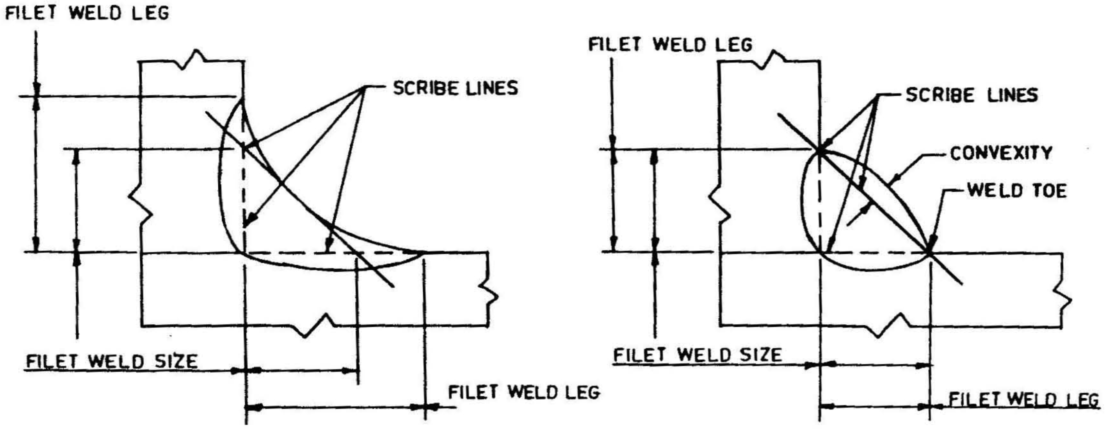
(*Clause* 5.8.2)

Sl No. (1)	Classification (2)	C % (3)	Mn % (4)	S % (5)	P % (6)	S % (7)	Ni % (8)	Cr % (9)	Mo % (10)	V % (11)	Al % (12)
i)	ET4XXXC9 ET4XXXM9	0.15	1.75	0.90	0.030	0.030	0.50	0.20	0.30	0.08	–
ii)	ET4XXXN9	0.30	1.75	0.90	0.030	0.030	0.50	0.20	0.30	0.08	2.0
iii)	ET5XXXC9 ET5XXXM9	0.15	2.0	0.50	0.030	0.030	0.50	0.20	0.30	0.08	–
iv)	ET5XXXXN9	0.30	2.0	0.90	0.030	0.030	0.50	0.20	0.30	0.08	2.0

NOTES

1 Single values are maximum.

2 Since Ni, Cr, Mo and V are not intentionally added, the total of these elements Ni % + Cr % + Mo % + V % shall not exceed 0.70 %.



13A CONCAVE FILLET WELD

13B CONVEX FILLET WELD

NOTES

1 Fillet weld size is the leg lengths of the largest isosceles right triangle which can be inscribed within the fillet weld cross section.

2 Convexity is the maximum distance from the gace of a convex fillet weld perpendicular to a line joining the weld toes.

3 Fillet weld leg is the distance from the joint root to the toe of the fillet weld.

FIG. 13 DIMENSIONS OF FILLET WELDS

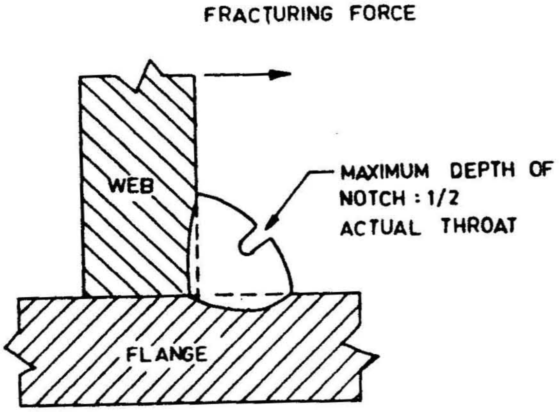
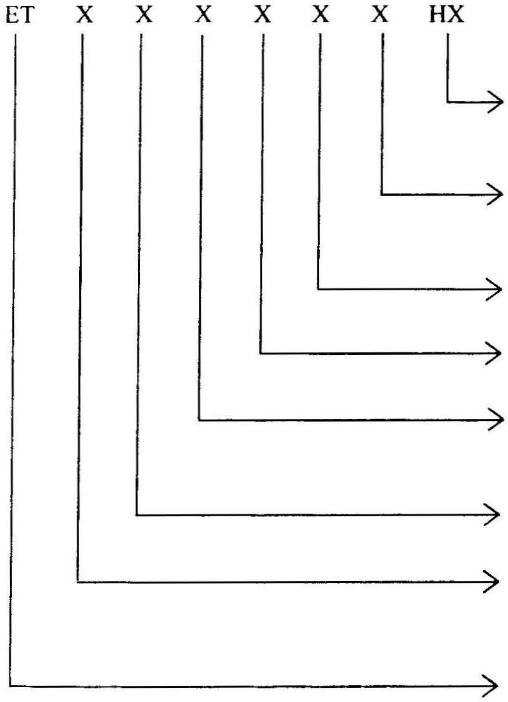


FIG. 14 METHOD FOR FACILITATING FILLET WELD FRACTURE

ANNEX A

(*Clause* 3.2)

CLASSIFICATION SYSTEM FOR THE FLUX CORED (TUBULAR) ELECTRODES FOR METAL-ARC WELDING OF CARBON OR CARBON-MANGANESE STEELS



ET X X X X X X HX

Indicates the maximum diffusible hydrogen content in the weld metal

Indicates whether the electrodes can be used for single-pass or multi-pass welding application

Indicates types of shielding gas

Indicates types of core ingredients

Indicates welding position in which the electrodes can be used

Indicates the impact values of the weld metal deposit

Indicates the ultimate tensile strength in combination with the yield strength and the elongation percentage of weld metal deposit

Indicates flux cored (tubular) electrodes for metal-arc welding

Examples of Electrode Classifications:

Flux cored (tubular) electrodes with rutile cored ingredients for metal arc welding of multi-pass joints in the flat and horizontal/vertical positions without shielding gas. The electrode is designed to give 15 m diffusible hydrogen content per 100 g of weld metal deposit.

The test results showed that the ultimate tensile strength of weld deposit was 450 N/mm^2 with 350 N/mm^2 yield strength and 24 percent elongation. The average impact value obtained was 30 Joules at –20°C. The classification of the electrode is therefore ET 420RN9H15.

ANNEX B

(*Clause* 4.4.6)

SAFETY CONSIDERATIONS

B-1 BURN PROTECTION

Molten metal, sparks, slag, and hot work surfaces are produced by welding, cutting and allied processes. These can cause burns, if precautionary measures are not used. Workers should wear protective clothing made of fire-resistant material. Pant cuffs, open pockets, or other places on clothing that can catch and retain molten metal or sparks should not be worn. High-top shoes or leather leggings and fire-resistant gloves should be worn. Pant legs should be over the outside of high-top shoes. Helmets or hand shields that provide protection for the face, neck, and ears, and a protective head covering should be used. In addition, appropriate eye protection should be used.

When welding overhead or in confined spaces, ear plugs to prevent weld spatter from entering the ear canal should be worn in combination with goggles, or the equivalent, to give added eye protection. Clothing should be kept free of grease and oil. Combustible materials should not be carried in pockets. If any combustible substance has been spilled on clothing, a change to clean, fire-resistant clothing should be made before working with open arcs or flames. Aprons, caps, sleeves, leggings and shoulder covers with bibs designed for welding service should be used.

Where welding or cutting of unusually thick base metal is involved, sheet metal shields should be used for extra protection. Mechanization of highly hazardous processes or jobs should be considered. Other personnel in the work area should be protected by the use of non-combustible screens or by the use of appropriate protection as described in the previous paragraph.

Before leaving a work area, hot work pieces should be marked to alert other persons of this hazard. No attempt should be made to repair or disconnect electrical equipment when it is under load: disconnection under load produces arcing of the contacts and may cause burns or shock, or both.

NOTE — Burns can be caused by touching hot equipment such as electrode holders, tips, and nozzles. Therefore, insulated gloves should be worn when these items are handled, unless an adequate cooling period has been allowed before touching.

B-2 ELECTRICAL HAZARDS

Electric shock can kill. However, it can be avoided. Live electrical parts should not be touched. The manufacturer's instructions and recommended safe practices should be read and understood. Faulty installation, improper rounding, and incorrect operation and maintenance of electrical equipment are all sources of danger.

All electrical equipment and work pieces should be grounded. The work piece lead is not a ground lead; it is used only to complete the welding circuit. All separate connection is required to ground the work pieces. The correct cable size should be used since sustained overloading will cause cable failure and can result in possible electrical shock or fire hazard. All electrical connections should be tight, clean and dry. Poor connections can overheat and even melt. Further, they can produce dangerous arcs and sparks. Water, grease, or dirt should not be allowed to accumulate on plugs, sockets, or electrical units. Moisture can conduct electricity. To prevent shock, the work area, equipment, and clothing should be kept dry at all times. Welders should wear dry gloves and rubber-soled shoes, or stand on a dry board or insulated platform. Cables and connections should be kept in good condition. Improper or worn electrical connections may create conditions that could cause electrical connections shock or short circuits. Worn, damaged or bare cables should not be used. Open circuit voltages can be additive. The added voltages increase the severity of the shock hazard.

In case of electric shock, the power should be turned off. If the rescuer must resort to pulling the victim from the live contact, non-conducting materials should be used. If the victim is not breathing, cardiopulmonary resuscitation (CPR) should be administered as soon as contact with the electrical source is broken. A physician should be called and CPR continued until breathing has been restored, or until a physician has arrived. Electrical burns are treated as thermal burns; that is, clean cold (ice) compresses should be applied. Contamination should be avoided; the area should be covered with a clean, dry dressing; and the patient should be transported to medical assistance.

B-3 FUMES AND GASES

Many welding, cutting, and allied processes produce fumes and gases which may be harmful to health. Fumes are solid particles which originate from welding electrodes and fluxes, the base metal, and any coatings present on the base metal. Gases are produced during the welding process or may be produced by the effects of process radiation on the surrounding environment. Management, welders and other personnel should be aware of the effects of these fumes and gases. The amount and composition of these fumes and gases depend upon the composition of the electrode and base metal, welding process, current level, arc length, and other factors.

The possible effects of overexposure range from irritation of eyes, skin and respiratory system to more severe complications. Effects may occur immediately or at some later time. Fumes can cause symptoms such as nausea, headaches, dizziness and metal fume fever. The possibility of more serious health effects exists when especially toxic materials are involved. In confined spaces, the shielding gases and fumes might displace breathing air and cause asphyxiation.

One's head should always be kept out of the fumes. Sufficient ventilation, exhaust at the arc, or both, should be used to keep fumes and gases from your breathing zone and the general area.

In some cases, natural air movement will provide enough ventilation. Where ventilation may be questionable, air sampling should be used to determine if corrective measures should be applied.

B-4 RADIATION

Welding, cutting, and allied operations may produce radiant energy (radiation) harmful to health. One should become acquainted with the effects of this radiant energy.

Radiant energy may be ionizing (such as X-rays), or non-ionizing (such as ultraviolet, visible light, or infrared). Radiation can produce a variety of effects such as skin burns and eye damage, depending on the radiant energy's wavelength and intensity, if excessive exposure occurs.

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